# CONTINUOUS AND PERIODIC SORPTION CRYOCOOLERS FOR 10 K AND BELOW

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The combination of long-life, negligible vibration, ability to be scaled easily over a wide range of cooling loads, low weight, and high efficiency makes sorption cooling a highly attractive technique for both periodic and continuous cooling of space instrument sensors to 10 K and below. Efficiencies are significantly greater than for Stirling or Pulse Tube coolers at this temperature, and weight/ lifetime ratios are much lower than for solid hydrogen or liquid helium cryogenic storage systems.

This paper summarizes the current status of sorption cryocooler development for 10 K and below. Flight test results for the Brilliant Eyes 10 Kelvin Sorption Cryocooler Experiment (BETSCE), and the design and fabrication of a small laboratory periodic 10 K sorption cryocooler are described. These periodic sorption coolers are ideal for applications that require only intermittent operation at 10 K, with quick cooldown capability (under 2 minutes). Designs for applications that require continuous cooling are also described, and performance predictions and important design challenges are discussed. Ground test results from a continuous 25 K cooler planned for use in a long duration airborne balloon experiment are also presented. This 25 K cooler can be used as an upper stage for a continuous 10 K sorption cooler. Similarly, the potential benefits of using a 10 K sorption cooler as an upper stage for a 4 K cooler are also described.

The 10 K cooling stages all expand, liquefy, and solidify H2 in a Joule-Thomson refrigeration cycle to produce the desired cooling effect. ZrNi hydride sorbent beds provide the low vacuum pressure (< 2.6x 10-4 MPa) needed to solidify the $H_2$. $LaNi_{4.8}Sn_{0.2}$ hydride sorbent beds are used to achieve the final compression to typical pressures of about 10 MPa. Thermally cycling the sorbent beds between about 290 to 550 K produces an overall compression ratio of over 105, without the use of any moving parts in the compressor.

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